Supplemental Instruction: Supporting Persistence in Barrier Courses

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Abstract

Courses that interfere with undergraduate students' persistence are barriers that appear all along the undergraduate continuum. Supplemental Instruction (SI) may contribute to students' achievement in a barrier course and, therefore, to their persistence in their academic program. The purpose of this single-case descriptive study was to explore student and instructor perceptions of SI in an upper-level chemistry course with a reputation for being a barrier to academic success. The case study methodology used included a focus group, one-on-one interviews with instructors and students, document review, and class and SI statistics. Results indicated that faculty and students perceived SI to be a valuable resource in achieving persistence or academic success.

Although the number of students enrolling in higher education has increased over the last 30 years, the percentage of students who are retained through graduation has not. According to the Division of Science Resources Statistics of the National Science Foundation, "trends in bachelor's degrees over the past 20 years…in engineering, physical sciences, and mathematics generally dropped or flattened out, especially since the mid-1990's" (Science and Engineering Indicators, 2006 page # 1-5). Providing undergraduate students academic resources that support academic achievement of the baccalaureate degree in their chosen field of study was the impetus for this study.

The variety of factors that influence a student's decision to stay in school cannot be underestimated and will no doubt continue to be the subject of significant consideration at institutions of higher education for the foreseeable future. The retention of undergraduate students has been the focus of study and consideration for thirty-plus years (Astin, 1975; Moxley, Najor-Durack, & Dumbrigue, 2001; Seidman, 2005; Volkwein, 1995). Further, the literature on student retention has considered the implications of institutional choice and the students' comfort at their chosen institution, students' involvement in academic and social activities, and students' perception of the value of

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a college degree coupled with the financial demand of college attendance. Research has also explored the significance of race, gender, and socioeconomic background as they relate to enrollment to degree completion success (Astin, 1975, 1984; Bean, 1980, 1983; Ford, 1996; Milem & Berger, 1997; Panos & Astin, 1968; Seidman, 2005; Tinto, 1975, 1982, 1988). The focus of this paper is academic barriers, specifically those courses that interfere with a student's successful continuation, persistence, in his or her well-chosen major – the barrier courses.

Background

Thirty years ago, A. Astin's (1975) seminal study researching retention in college found that "many undergraduate institutions fail to capture the interest of substantial numbers of students, including some of the highest achievers" and that "if ways can be found to involve students more in the life and environment of the institution, their chances of staying in college are improved" (p. 148). According to Astin (1975, 1984) and others (Milem & Berger, 1997; Tinto, 1988) providing students with activities that include academic as well as social interactions enhances retention. A compounding issue is persistence. "The words persistence and retention are often used interchangeably. The National Center for Education Statistics, however, differentiates the terms by using retention as an institutional measure and persistence as a student measure. In other words, institutions retain and students persist" (Hagedorn, 2005, p. 92). Resources that support students' persistence automatically result in improved retention rates.

Activities directed at improving retention rates have been initiated at an increasing number of colleges and universities such as first year seminars, cluster courses, and living-learning communities. The preponderance of these programs addresses the needs of first year students (Markham, 1996; Tinto, 2005). Frequently such programs are aimed at helping students learn how to become more successful students. One such program is known as Supplemental Instruction (SI). SI is an academic support program that combines academic and group activity by providing peer support in the courses that many students find difficult. SI sessions are regularly scheduled reviews that focus on recent course content; SI leaders are role models for academically achieving undergraduates. The University of Missouri Kansas City, original home and current international center for SI, maintains a website that lists colleges and universities across the United States and in 11 other countries that offer SI programs.

Although not considered a remedial program, a review of many of these sites seems to indicate that SI programs are often directed toward first or traditionally considered gateway courses. While these programs are certainly important (Ford, 1996), it is equally important to consider that there may be academic barriers all along the undergraduate continuum, through the upper-level advanced courses. The researcher and author of this article is the director of an academic support center that provides the setting for this study. A continual effort to improve the program led to this study.

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(St. John & Wilkerson, 2006) suggests that programs to support persistence are needed, especially initiatives that address campus specific needs and are assessed for their value: "Although substantial gains are apparently being made in retention during the first two years of college, there are also critical challenges related to persistence to degree completion" (p. 101). The popularity of SI in this upper-level chemistry course suggested that students appreciated the resource. This study was undertaken in order to determine if SI is viewed as an effective strategy for academic achievement in a perceived barrier course required of science majors at a public doctoral/research extensive flagship university, referred to here as Flagship State University (FSU).

Students' lack of persistence in their chosen field of study has a variety of personal, institutional, and, in some cases, national implications, as previously noted. Persistence in a student's major is indicated by academic success through graduation; courses known to interrupt this success are referred to here as barrier courses. The contribution of SI to student success, particularly in barrier courses, may be a proactive intervention that is effective in reducing attrition rates and supporting persistence.

Methodology

A case study methodology was employed to explore the perceived benefits of SI in a course (Physical Chemistry) that is well known for its difficulty among students and faculty alike. This course is required for Biochemistry and Molecular Biology, Chemical Engineering, and Chemistry majors and is populated with upper-level achieving science students. A trial semester of SI in this course resulted in higher than anticipated attendance at SI sessions, making it a most compelling case for investigation.

This research took place at a doctoral/research extensive land grant university, herein referred to as Flagship State University, FSU. This university is the flagship campus of a 5-campus state university system in the Northeast. SI was first offered at FSU through an academic support center in 1996. Consistent with the approach to SI offered elsewhere, SI sessions were open to all students and presented as simply an option for increased exposure to difficult material in four to eight entry-level classes. SI leaders attended every session of the class and held regularly scheduled twice-weekly 75-minute review sessions at the academic support center. SI is now available in 25 to 30 courses every semester at FSU. A combination of student and faculty requests has dictated the inclusion of SI in these courses. A few notable requirements in the sciences remain some of the most difficult for students to successfully complete, among them Physical Chemistry.

Surveys of students in courses offering SI suggested that attendance at the sessions was largely dictated by a combination of course difficulty and importance and the relative benefit of SI. Students who attended SI sessions appreciated the support it provided them to achieve in those courses. The degree of course difficulty and the importance of the course relative to students' academic goals were, however, reportedly the important criteria

in students' decision to attend SI sessions. This observation seemed to suggest that SI could positively contribute to students' persistence in their chosen major when and if there was support for them in the courses that they found most difficult.

As noted earlier, Physical Chemistry has a reputation among students and professors in the sciences as an academic hurdle or barrier (or 'weeder') course for many students. A student already employed by the academic support center suggested that the students in this upper-level chemistry course would benefit from SI support because, according to this student, it requires mathematics that students do not otherwise make use of, contributing to the perception of this course as a barrier to academic success. The professor teaching the course was contacted and responded with interest in a trial of SI support for Physical Chemistry. As a result, SI was offered in Physical Chemistry during the fall 2001 semester. At least 85% of the students enrolled in the course participated in a minimum of 2 SI sessions during that trial semester. SI support was provided for Physical Chemistry the subsequent semester and attendance was comparable. As noted, this study was undertaken to explore the perception of SI as an effective strategy for academic achievement in this course with a reputation that tends to generate anxiety. The primary participants were students enrolled in Physical Chemistry during the fall 2006 semester. All students enrolled in Physical Chemistry during the fall 2006 semester were informed of this study and agreed to participate; respondents were given an Informed Consent Form explaining the objectives and purpose of the study and their rights as participants which they all willingly signed. Pseudonyms have been used to protect the identification of people and place throughout.

The primary method for data collection was one-on-one interviews with students enrolled in Physical Chemistry; the past and present course instructors and the current SI leader were also interviewed. One focus group comprised of six students was held and provided an opportunity to review students' interview questions and begin to get a feel for students' opinions. According to Yin (2003), the interview provides essential information for a case study. Coupled with focus groups, one-on-one interviews provided greater opportunity to explore selected students' perceptions of SI and assured that the student voice was the primary data source. Six students enrolled were interviewed individually. Interviews with the professors corroborated information reported by students. Saturation occurred early in the interview process; no additional data was revealed after completion of several one-on-one interviews with students although several additional one-on-one interviews were completed. Saturation indicates that continued interviewing will no longer yield additional information (Rubin & Rubin, 1995; Creswell, 1998; Hatch, 2002). Student responses were more similar than anticipated; saturation occurred and categories emerged. Interview data was consistent with student responses noted anecdotally by learning center staff. Document review included course description and requirements as well as any other printed material regarding Physical Chemistry. Attendance records from SI sessions and final grades were collected and analyzed as was a class survey on SI participation.

Results and Discussion

Four categories were identified in the field notes as pivotal to students' engagement in SI. They included anxiety about the course, course content, characteristics of students, and students' perception of academic resources.

Anxiety

The reputation of Physical Chemistry instigates the apprehension students report related to Physical Chemistry. Three factors frame this academic hurdle: it has a reputation, it is a requirement, and it is a challenge. Further, the significance of the anxiety reported regarding this course is noted in the regard of this course as a barrier. This perception tends to be reinforced as students cycle through an academic barrier.

The caution students report in anticipation of Physical Chemistry is notable. Students admit feelings that range from caution to dread prior to their enrollment in this course. The study of physical chemistry is perceived as a hurdle even before experience with the course begins. The forewarning students receive regarding this course leads to the apprehension students frequently experience when they consider enrolling in this course. Some students admit to putting off the study of Physical Chemistry until their last year as an undergraduate simply because they are afraid of it. It is this reputation that initiates the cycle of an academic barrier.

The cycle is perpetuated by the fact that the course is required; this exacerbates the feelings of anxiety students report regarding Physical Chemistry. Both students and faculty admitted knowing someone who changed their major field of study while an undergraduate student because of fear about the required Physical Chemistry course. Switching from a chosen field of study to avoid a required course is an extreme reaction to a course, yet knowing someone who had done exactly that was mentioned in several of the one-on-one interviews and referred to among focus group participants. Many of the students in the majors that do require the study of Physical Chemistry plan on attending graduate school, and they need to do well in this course to do so. This required course is a necessary hurdle.

The challenge for academic achievement in such a difficult course completes the cycle of an academic hurdle or barrier (see Figure 1). The course is important not only because it is required but because students need to be competent in the subject matter to continue in their discipline. The subject matter is complicated and challenging throughout the semester. Students frequently remain anxious about this course even when they are taking advantage of resources, particularly SI, and performing well on examinations.

The cycle of an academic barrier is illustrated in Figure 1. The cycle begins with a course's reputation. This initiates the feelings of anxiety that make students wary about a course even before they are introduced to the subject matter. Students are clear that this course is a major hurdle for them. The difficult course material is a challenge for the duration of the course. As students rotate through this barrier during the semester, anxiety is present throughout. This pattern is diagramed below.

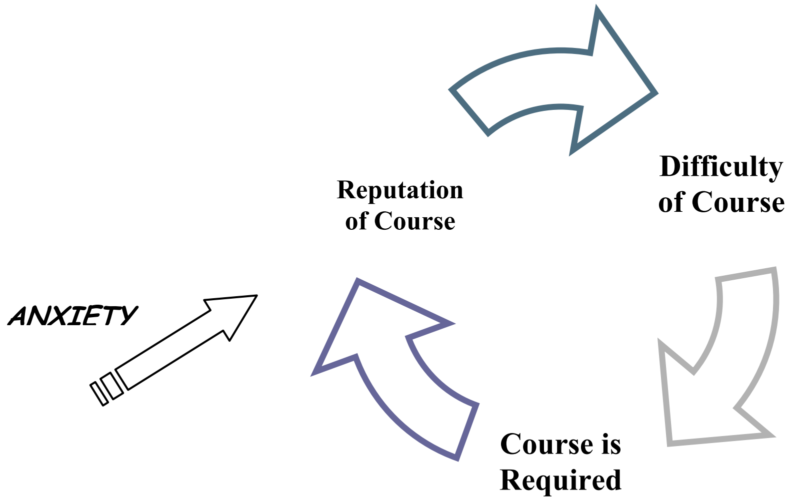

Figure 1. Cycle of an Academic Barrier

Course Content

The course content is complex; the case study data revealed two major factors that have significance regarding the implications of the course content: the mathematics and the complex nature of the course material.

The study of Physical Chemistry is the combination of mathematics and physics as well as chemistry. The mathematical component is a major hurdle for many students; transitioning between the disciplines is an additional hurdle. Although all students must complete the same prerequisites for this class, their backgrounds vary depending on their major. Most students find the mathematical component challenging—even when their mathematical background is strong. The complex nature of Physical Chemistry demands an ability to integrate conceptual information from three sciences. Apparently it is not the chemistry that is difficult but rather the physics and mathematics and eventually the integration of all three.

Students intent on completing their bachelors' degrees in one of the three majors that require the study of Physical Chemistry are accustomed to difficult course work. They are also accustomed to receiving good grades in these difficult courses according to data collected in interviews with participating students. Course instructors are aware that the typical student enrolled in Physical Chemistry is unaccustomed to struggling to understand course material. Physical Chemistry is a hurdle for most students. The cycle of an academic barrier is evidenced in the challenge students face while they are enrolled in Physical Chemistry. The difficult nature of the course promotes the continuing perception of this course as an academic barrier.

Student Characteristics

Students do confirm their willingness to take advantage of academic resources. They also appreciate the value of working through difficult material in a group, led by an experienced student. Participants in this class frequently refer to the fact that a number of their classmates are known to them from previous science classes and that they have occasionally struggled through labs together. They have struggled with their colleagues before and are willing to do so here. Students in Physical Chemistry tend to be aware of available resources and frequently expressed their appreciation for SI in this course. The cycle of a barrier course continues through this stage of students dealing with the academic challenge of Physical Chemistry.

The previous course professor was quite convinced that the fact that all students enrolled in Physical Chemistry are generally in their third year of study at a university and committed to their studies contributes significantly to the number of students who attend the SI sessions for that course. These are serious students accustomed to working hard and doing well. This is possible in Physical Chemistry but for most it requires taking advantage of resources. The current professor firmly believes that because these are students accustomed to doing well in class they prefer the safety of their peers to practice with the difficult material as opposed to the potential for or at least the perception of judgment by the authority, the course instructor. Students confirm this belief. As one student reported,

> It's more like you go when you've been presented with something in class that you're like 'what?' and the you go [to SI] and there is someone you can talk to on your level that can explain it to you….Just the whole age and peer-to-peer kind of learning I think is so much more effective.

Students' Perceptions of Academic Resources

A. Astin (1975) noted that achieving students are apt to take advantage of available resources, particularly with difficult courses. Instructors acknowledge the difficult courses and support students in this direction. All respondents talked about the value of SI in Physical Chemistry. The factors noted regarding SI and Physical Chemistry are the reduction of student anxiety, the support of student learning of complex course content, and the academic resource fits students' needs.

The particularly difficult subject matter and the perceived benefit of participating in SI have resulted in the noted attendance pattern in the SI sessions of Physical Chemistry. All but six students in the fall 2006 cohort of 56 students attended at least one session of SI; seven students attended only one SI session. One of the students who reported only attending one session said that she simply does not struggle the way many of her colleagues do; in fact, she is enthusiastic about the challenge of Physical Chemistry. Her appreciation for the exciting challenge of the difficult course material is not shared among her classmates. Regardless of her enthusiastic attitude about the challenge of Physical Chemistry, she is equally enthusiastic about SI. She willingly admits not wanting to consider Physical Chemistry (or Organic Chemistry) without SI.

The anxiety that this course generates has been amply noted. SI gives students the opportunity to work with difficult material in as many ways as they desire. Participating faculty and students suggested that this opportunity helps reduce this anxiety—both by increasing their time on the task in a supported environment and by the chance to process the difficult course material with their peers. Students frequently commented on SI as the perfect place to get help with complicated homework. A number of these students were known to each other from previous science courses. They basically followed each other to an initial SI session; most students repeated visits throughout the semester. Students were clear that they considered SI to be extremely valuable not only for help with homework but for a greater understanding of difficult course material. Students who did not attend SI sessions frequently were as supportive about the benefits of SI, particularly with regard to Physical Chemistry, as students who attended more frequently. In all cases students were glad it was available to them. Physical Chemistry is clearly considered an academic hurdle—SI provided the necessary support for their academic achievement, thereby allowing them to persist in their science major.

SI Attendance and Grades

Only one professor at FSU has taught Physical Chemistry both with and without SI. When asked if there was a notable difference between the classes, he replied that, given that no two classes are actually alike, there were two obvious differences between the last year without SI and the first year with it. One difference was the reduced frequency that students came to his office hours struggling with course content. The other difference was the amount of students who received the grade of A. "In general I've tended to give roughly ten percent of the class A's. That's kind of the ball park, so in a class of fifty there'll typically be about five A's. But the last year there were twenty-five [out of fifty-six enrolled students]!" (S. Albert, Personal Communication, September 25, 2006). Attendance patterns at SI sessions for Physical Chemistry are a clear indication that students find this a valuable resource. Whether or not this resource actually contributes to improved academic performance is not as clear. The grades from Physical Chemistry for the fall 2001 semester, the last semester of teaching this course without the support of SI, were compared to Physical Chemistry from the fall 2003 and 2004 semesters which the same professor also taught. The grades from Physical Chemistry fall 2001 semester were also compared to Physical Chemistry 2005 and 2006 fall semesters which were taught by the current professor. The homogeneity of variance assumption was satisfied, so we can assume that the same variety was present in each population. The population of scores from each semester was entered as populations in a One-way Analysis of Variance (ANOVA) to test for the differences between the groups. Results of these planned comparisons indicate that differences in grades with and without SI, regardless of instructor, are statistically significant. These findings demonstrate improved grades, defined as an increase in the grades of B and better, with the inclusion of SI. The professor's report of

the higher scores on examinations and homework assignments throughout the semester corroborate this statistic. The improved distribution of grades without the inclusion of SI in 2001 and with in 2006 is demonstrated in the table below. Although these grades reflect two distinct although similar class cohorts, the relative improvement in grade of B or better is notable.

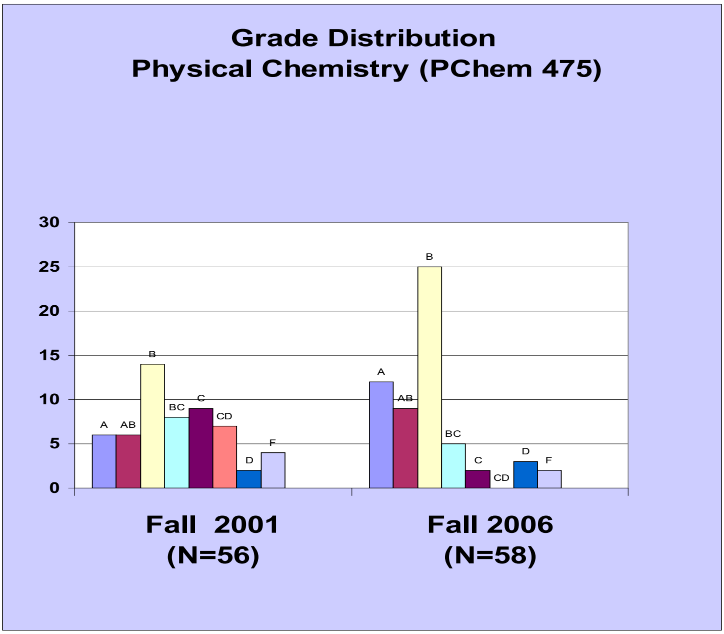

Figure 2. Grade Distribution in PC4 2001 (no SI) v. 2006 (with SI)

At FSU, not unlike other colleges and universities, attendance at SI sessions is voluntary. Students are free to attend whenever they choose. SI leaders respond to students' questions and prepare worksheets with strategies for learning the difficult course material. Peaks in attendance are an obvious reflection of preparing for examination or completing a difficult graded homework assignment. The academic resource center staff noted that there are some courses that seem to have steadier attendance patterns than others. A comparison of attendance patterns of courses along the chemistry continuum illustrates this point. The table below reveals the increase in the average percentage of students who participated in SI for General Chemistry (1xx), Organic Chemistry (2xx), and Physical Chemistry (4xx).

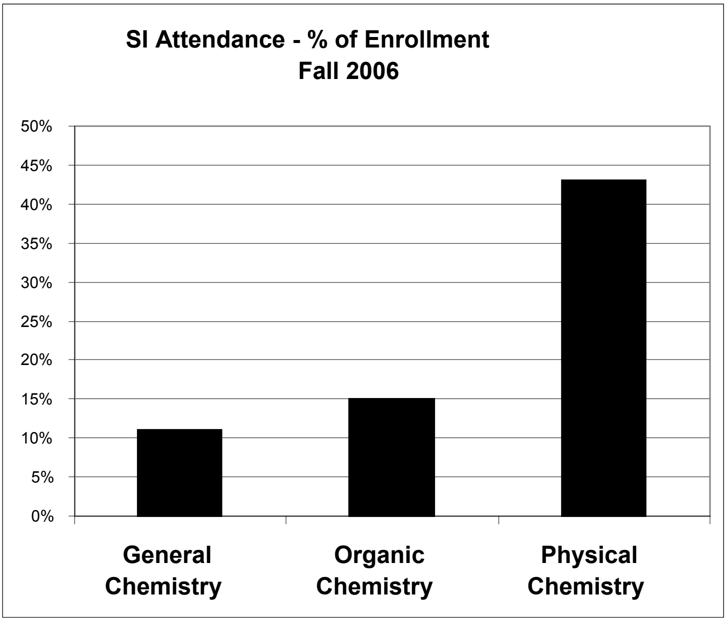

Figure 3. Average SI Attendance

Students enrolled in Physical Chemistry were given a survey in class during the penultimate week of the fall 2006 semester. Students were asked whether they had participated in any SI sessions for this course. If they had, they were asked whether they were helpful and if they believed that attending SI sessions helped them obtain a better grade. Thirty-seven surveys were returned; of those, 32 attended at least one SI session, 30 students attended at least two sessions. Five students indicated that they had not attended any SI sessions; only one of those students reported that s/he didn't feel they were necessary. The remaining four students had time constraints that precluded their attendance at any SI sessions although they were interested in attending. Only four students who reported attending at least one SI session did not believe that attendance improved their grades; only two students reported that the SI sessions were not helpful to them.

Attendance patterns alone suggest that students enrolled in Physical Chemistry appreciate the value of Supplemental Instruction, SI. The statistics that describe the differences in grades between the several semesters confirm what a professor noticed and students indicate: SI is an appreciated resource.

Discussion

This study asked why students in Physical Chemistry participate in SI and what factors influence this decision; and if SI is an effective strategy in supporting persistence in SME majors. According to interview data and improved grades, it does appear that participation in SI contributes to academic success and therefore persistence through this difficult course. Students who participated in SI in Physical Chemistry were enthusiastic in their appreciation for this resource. They expressed interest in its availability for other difficult courses along their academic trajectory. This may suggest that SI could contribute to improved persistence in SME disciplines. Students who take advantage of this resource in order to succeed in this course, thereby assure their persistence in their science major.

Students become aware of the "weed-out" or barrier course either because it is referenced as such by a member of the faculty, it is discussed by students, or it is taught at a level that favors the most advanced students (Seymour & Hewitt, 1997). It is clear that these barrier courses actually occur throughout the undergraduate journey. Barrier courses occur in a wide variety of disciplines; however, they all share a reputation that generates anxiety, they are all difficult, and they are all required courses. Just as SI has been shown to positively influence students' academic achievement consistently in first-year courses over the past 30 years, it can positively contribute to academic achievement in the very courses that make it difficult for students to persist in their chosen discipline.

SI is a highly effective academic support program: "This model, which has been used for more that thirty years, still yields strong results in student learning, higher final course grades, and lower DFW rates across disciplines, types of colleges, and student ethnicities" (McGuire, 2006, p. 21). Its value as a resource is evident. As students progress through the academic continuum of their undergraduate years, they hit academic barriers or hurdles along the way. Occasionally these barriers are enough to derail students.

It seems that the perception of a barrier can begin before the student ever enters the classroom. The reputation of a difficult course precedes a student's enrollment and can even dissuade a student from ever entering the classroom. Students who have familiarity with the SI program may anticipate participating in SI in the barrier course whether or not they have ever participated in an SI session related to previously taken courses. The relief of its presence can be enough to convince a student to at least enter the classroom. This study suggests that the cycle of an academic barrier can be interrupted by a well-received academic program as noted in Diagram 2, which depicts the process through an academic barrier.

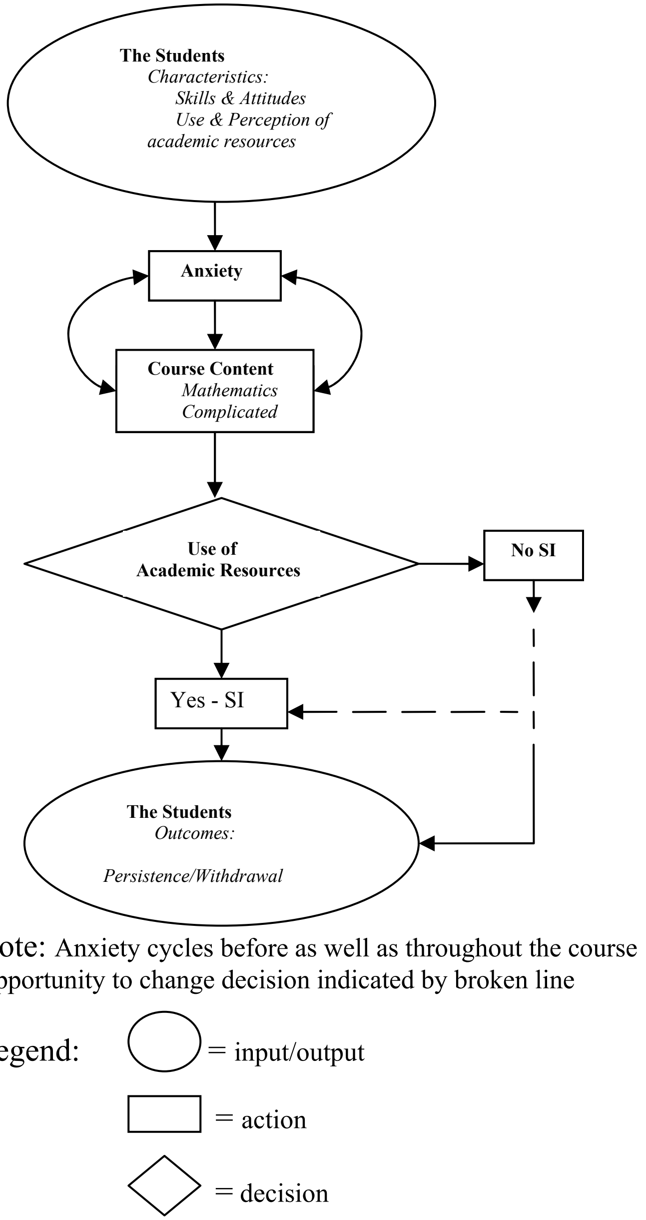

Figure 2. The Process Through an Academic Barrier

Recommendations for future research relate to student development. Research regarding the upper-level students' self-identity as competent students willing to seek assistance may contribute to further understanding of first and second year students as they struggle to become successful

autonomous university students. This study indicated that the students interviewed were in a place along the developmental continuum to take advantage of whatever resources were available to them. Helping first and second year students understand the importance of available resources would certainly be beneficial. Further studies should continue exploring ways to provide academic support programs that address students' needs before the barriers interfere with their progress.

Broader Implications

The application of the scientific method to mentoring activities is applicable to all academic areas—not just the sciences. Although my mentoring activities primarily involve students in the areas of science, technology, engineering, and mathematics, other faculy members at the Center for Academic Success mentor protégés in a wide variety of disciplines. The steps involoved in applying the scientific method to mentoring are generally applicable to any mentoring experience. Learning about the characteristics of the protégé, developing hypotheses about the problem to be addressed, jointly developing a menu of strategies, implementing the strategies, analyzing the success, developing conclusions about the efficacy of specific strategies, and subsequently modifying strategies based on the results will make the mentoring experience an enjoyable and satisfying one for both the protégé and the mentor. The broad applicability of these methods suggest that they can be used for students in all types of institutions and at all levels. The specifics of the mentoring experience will change, but the basic framework is sufficiently robust so that, when applied according to the scientific method, it will yield positive results in any mentoring situation.

Conclusion

The process through an academic barrier begins and ends with students. The reputation of a required difficult course can create the perception of a hurdle or academic barrier. The unique skills and attitudes of students contribute to their expectations of a course as well as their ability to succeed. In a course perceived to be as difficult as Physical Chemistry, students report a level of anxiety throughout the semester. The expectation of difficult course material is confirmed throughout the semester. Students report that academic resources, particularly SI, abate anxiety and support academic success for those who participate. SI participation is completely voluntary and students are able to decide to participate in SI throughout the semester. Students suggested that participation in SI positively contributed to their academic achievement in Physical Chemistry. It provided a safe environment and peer support in the course, breaking the cycle of an academic barrier.

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